

Revised Dilution for Increased Flow at Samoa Packing

The original mixing zone application was prepared during the final design stages of the diffuser and documents both the final optimization of the diffuser configuration and the performance of the final diffuser design. The final diffuser configuration is described on page 14 and the design performance is described starting on page 18 of the 1991 Technical Memorandum. The selected diffuser configuration and the critical conditions used to determine performance were as shown in Table 1. The conditions used all represented the most critical conditions resulting in predicted dilution lower than expected.

Table 1. Design Parameters of JCO Diffuser		
Diffuser Characteristics		
Number of Active Ports	4	2 blocked ports for future expansion
Port Size	5 inches	
Port Spacing	50 feet	Ports discharge to alternate sides of barrel
Port horizontal orientation	90°	Perpendicular to barrel
Port vertical orientation	15°	Upward from horizontal
Effluent Characteristics		
Effluent Flow	1.41 mgd 2.39 mgd 3.40 mgd	
Effluent Temperature	85 °F	
Effluent Salinity	F(flow)	0.6 mgd seawater as worst case based on StarKist thaw water cycle
Ambient Conditions		
Current Speed	0	As a very conservative assumption
Density Profile	Strong	Most critical profile considered

The model runs for these conditions are provided in Appendix A of the 1991 Technical Memorandum for both the weaker and stronger (critical) density gradients that were developed to describe the range of conditions expected at the diffuser location. The final predicted performance of the final configuration is provided in Table 12, page 20, of the 1991 Technical Memorandum. The dilution information is reproduced below in Table 2, which includes additional results of the model runs not tabulated in the 1991 Technical Memorandum.

Table 2. Predicted JCO Diffuser Performance			
Density Gradient	Effluent Flow	Initial Dilution to Trapping Level	Total Initial Dilution ¹
Stronger Gradient	1.41	467	559
	2.39	393	496
	3.40	346	439
	4.30 ²	313 ³	--
		317 ⁴	399 ⁴
Weaker Gradient	1.41	817	881
	2.39	659	693
	3.40	586	586

¹ Included in model output but not in text of 1991 Technical Memorandum

² Not used in original analysis of the 1991 Technical Memorandum

³ Estimated from curve fit as described in text.

In Table 2 the “initial dilution to the trapping level” is the dilution calculated as the plume first passes through the equilibrium depth or trapping level in the water column where the density of the plume is equal to the density of the receiving water. This is often interpreted as the initial dilution for evaluation of water quality compliance. However, the plume keeps rising because of its momentum and rapid initial dilution continues as indicated in the “total initial dilution” column in Table 2. In fact, after reaching maximum height the plume will subsequently collapse with initial dilution still increasing. The model used (UDKH DEN) does not predict this dilution during final collapse.

When the COS Samoa Packing effluent flow was increased, resulting in the combined flow increase to 4.3 mgd, the effect on initial dilution was estimated by plotting the dilution as a function of flow as shown in Figure 1. Application of the regression equation shown predicts a dilution of 337:1 for a flow of 3.62 mgd and 313:1 for a flow of 4.30 mgd. For this mixing zone application the model was rerun for identical input parameters and the result and initial dilution was 317:1 as shown in Table 2. The difference in dilutions between 313:1 and 317:1 is within the resolution and sensitivity of the models the two values are essentially identical. The model run results are shown in Figure 2.

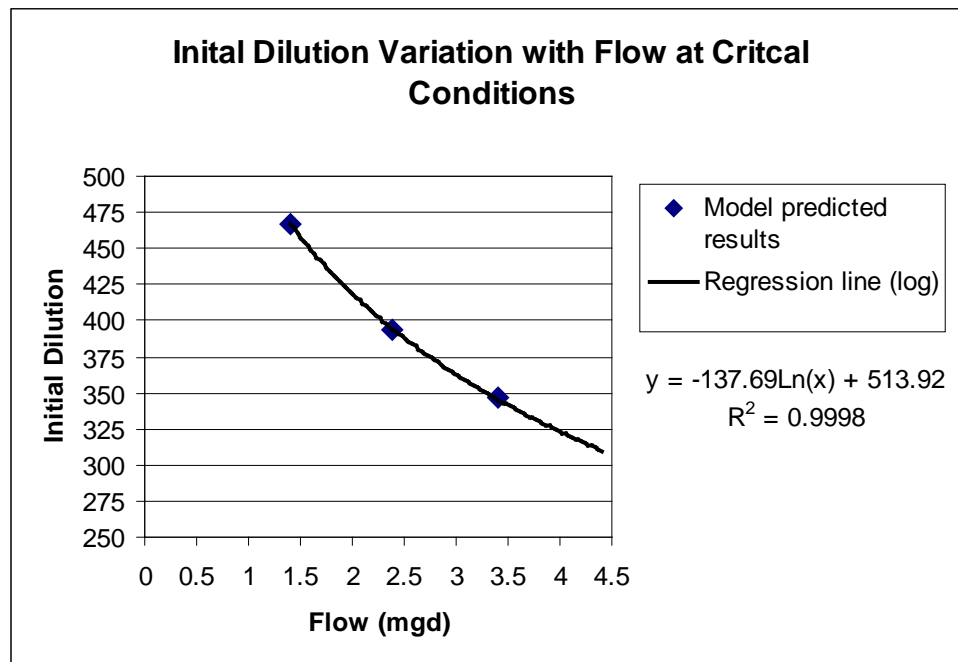


Figure 1. Predicted Dilution Results for Strong Density Gradient

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                                PROGRAM UDKHDEN
                                SOLUTION TO MULTIPLE BUOYANT DISCHARGE PROBLEM WITH
                                AMBIENT CURRENTS AND VERTICAL GRADIENTS.   AUG 1985
UDKHEN CH2MHILL Version 2.2 (1-24-89)
UNIVERSAL DATA FILE: 43strg.in
CASE I.D. Joint Cannery Outfall Inital dilution Prediction: Stronger Density Gradient
RUN TITLE: Flow = 4.3 mgd and strong density gradient
DISCHARGE= 0.1884CU-M/S  ** TEMPERATURE= 29.44-C  ** SALINITY= 4.950-PPT  ** DIAMETER= 0.1287
** NUMBER OF PORTS= 4  ** SPACING= 15.24-M  ** DEPTH= 53.34-M
    AMBIENT STRATIFICATION PROFILE
      DEPTH (M)      TEMP (C)      SALINITY (PPT)  DENSITY (G/CM3)  VELOCITY (M/S)
      0.00          27.30          35.50          1.02302          0.000
      3.00          27.30          35.50          1.02302          0.000
      6.00          27.20          35.60          1.02313          0.000
      9.00          27.20          35.60          1.02313          0.000
     12.00          27.20          35.70          1.02320          0.000
     15.00          27.20          35.80          1.02328          0.000
     18.00          27.20          35.80          1.02328          0.000
     21.00          27.20          35.80          1.02328          0.000
     24.00          27.20          35.90          1.02336          0.000
     27.00          27.20          35.90          1.02336          0.000
     30.00          27.20          35.90          1.02336          0.000
     33.00          27.20          35.90          1.02336          0.000
     36.00          27.20          35.90          1.02336          0.000
     39.00          27.20          35.90          1.02336          0.000
     41.00          27.20          35.90          1.02336          0.000
     44.00          27.20          35.90          1.02336          0.000
     47.00          27.20          35.90          1.02336          0.000
     49.00          27.20          36.00          1.02343          0.000
     55.00          27.20          36.00          1.02343          0.000
FROUDE NO= 20.86,  PORT SPACING/PORT DIA= 118.41  STARTING LENGTH= 0.744
ALL LENGTHS ARE IN METERS-TIME IN SEC.  FIRST LINE ARE INITIAL CONDITIONS.
      X      Y      Z      TH1      TH2      WIDTH      DRHO      DTCL      DSCL      TIME      DILUTION
      0.00    0.00    0.00    90.00    15.00    0.13      1.000    1.000    1.000    0.00      1.00
      0.00    0.72    0.20    90.00    16.02    0.35      0.995    0.995    0.995    0.21      1.94
      0.00    1.70    0.51    90.00    20.07    1.14      0.306    0.304    0.304    0.79      6.33
      0.00    2.64    0.92    90.00    27.56    1.89      0.180    0.178    0.178    1.98     10.79
      0.00    3.51    1.47    90.00    36.63    2.57      0.126    0.125    0.125    3.67     15.41
      0.00    4.29    2.15    90.00    45.37    3.17      0.096    0.095    0.095    5.72     20.30
      0.00    4.96    2.92    90.00    52.72    3.70      0.076    0.075    0.075    8.01     25.52
      0.00    5.54    3.77    90.00    58.55    4.20      0.062    0.062    0.062    10.45    31.13
      0.00    6.04    4.67    90.00    63.08    4.67      0.051    0.052    0.051    12.99    37.15
      0.00    6.48    5.61    90.00    66.51    5.14      0.041    0.044    0.041    15.62    43.56
      0.00    6.87    6.56    90.00    69.11    5.62      0.033    0.038    0.033    18.34    50.35
      0.00    7.21    7.53    90.00    71.23    6.10      0.029    0.034    0.029    21.16    57.49
      0.00    7.82    9.50    90.00    74.52    7.04      0.023    0.026    0.023    27.02    72.78
      0.00    8.32    11.49    90.00    76.95    7.96      0.019    0.022    0.018    33.15    89.39
      0.00    8.75    13.51    90.00    78.78    8.87      0.016    0.018    0.015    39.51   107.26
      0.00    9.13    15.53    90.00    80.21    9.77      0.013    0.015    0.013    46.08   126.33
      0.00    9.46    17.56    90.00    81.35   10.66      0.011    0.013    0.011    52.84   146.55
      0.00    9.75    19.60    90.00    82.27   11.55      0.010    0.011    0.010    59.78   167.88
      0.00   10.01    21.64    90.00    83.04   12.44      0.009    0.010    0.009    66.88   190.27
      0.00   10.25    23.69    90.00    83.68   13.32      0.008    0.009    0.008    74.14   213.67
      0.00   10.47    25.74    90.00    84.22   14.20      0.007    0.008    0.007    81.55   238.05
      0.00   10.67    27.79    90.00    84.68   15.07      0.006    0.007    0.006    89.10   263.37
    PLUMES MERGING
      0.00   11.02    31.89    90.00    85.26   16.67      0.001    0.006    0.001   104.56   308.49
    PLUMES HAVE REACHED EQUILIBRIUM HEIGHT - STRATIFIED ENVIRONMENT
      0.00   11.17    33.69    90.00    85.26   17.57      0.000    0.006    0.000   111.71   325.25
      0.00   11.26    34.71    90.00    85.26   18.06      0.000    0.006    0.000   115.96   334.18
      0.00   11.34    35.74    90.00    85.26   18.53      0.000    0.006    0.000   120.34   342.74
      0.00   11.43    36.76    90.00    85.25   18.98      0.000    0.005    0.000   124.82   350.98
      0.00   11.51    37.79    90.00    85.25   19.43      0.000    0.005    0.000   129.42   358.94
      0.00   11.60    38.82    90.00    85.24   19.88     -0.001    0.005    -0.001   134.13   366.63
      0.00   11.69    39.84    90.00    85.15   20.50     -0.003    0.005    -0.003   139.00   374.01
      0.00   11.77    40.87    90.00    84.93   21.40     -0.005    0.005    -0.005   144.14   380.93
      0.00   11.87    41.89    90.00    84.51   22.78     -0.007    0.005    -0.007   149.77   387.18
      0.00   11.97    42.92    90.00    83.73   25.15     -0.008    0.005    -0.009   156.28   392.54
      0.00   12.10    43.94    90.00    81.99   30.68     -0.009    0.004    -0.009   164.92   396.62
      0.00   12.29    44.95    90.00    74.24   59.27     -0.009    0.004    -0.009   180.20   398.98
    PLUMES HAVE REACHED MAXIMUM HEIGHT - STRATIFIED ENVIRONMENT
    TRAPPING LEVEL= 20.56 METERS BELOW SURFACE,  DILUTION= 316.97

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Figure 2. UDKHDEN results for effluent flow of 4.3 mgd and strong density gradient